

CLAIMS:

1. A method for generating a 2-D image projection directly from a 3-D volume data, the method comprising the steps of:
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 - a) determining a viewing direction vector in a viewing frustum, the viewing frustum containing a plurality of viewing vectors;
 - b) determining a major axis of the viewing direction vector;
 - c) re-sampling a selected set of the viewing vectors in the volume data with a
10 refined grid according to a selected image parameter, the re-sampling in a direction of said major axis;
 - d) applying a shear factorization to the re-sampled data according to the selected image parameter; and
 - e) applying a warp operator for rendering the factorized data for producing said
15 2-D image projection;wherein the image parameter is selected so as to provide each vector of the selected set of viewing vectors with the same major axis of the direction vector.
2. A method according to claim 1 further comprising the step of determining said
20 viewing frustum by specifying positional data of a viewing point and a central point, said central point to be substantially centered in said 2-D projection.
3. The method according to claim 2, wherein said positional data of said viewing point further includes direction of orientation data of said viewing point in said volume
25 data.
4. The method according to claim 2, wherein said viewing frustum is a truncated pyramidal geometrical structure.
- 30 5. The method according to claim 4 further comprising the step of determining boundaries of said viewing frustum by constructing boundary vectors, each of the boundary vectors including said viewing point and extending to each respective corner of said volume data, wherein said viewing point is positioned external to the positions contained by said volume data.

- 5 6. The method according to claim 5 further comprising the step of employing geometrical information obtained from said boundary vectors for determining the image parameter used to select a resolution of said refined grid, the image parameter being a step size.
7. The method according to claim 1 further comprising the step of using the major component of said viewing direction vector for determining said major axis.
- 10 8. The method according to claim 7 further comprising the step of selecting the image parameter for determining a resolution of said refined grid, the image parameter being a step size.
- 15 9. The method according to claim 8, wherein said step size is used for providing a plurality of viewing vectors in said viewing frustum having the same said major axis in an object viewing space as said viewing direction vector.
- 20 10. The method according to claim 9, wherein said viewing direction vector contains a viewing point and a central point, said central point is substantially centered in said 2-D image projection.
- 25 11. The method according to claim 9, wherein a plurality of viewing vectors in said viewing frustum are rendered with the same factorization matrix.
12. The method according to claim 9 further comprising the step of using one copy of said volume data for applying said shear factorization.
- 30 13. The method according to claim 12 further comprising the step of accessing said volume data in a pre-defined storage order.
14. The method according to claim 13, wherein said volume data is stored in a memory in a stack of 2-D image slices.

15. The method according to claim 14 further comprising the step of accessing said memory once for every selected one of the image slices in said stack.
- 5 16. The method according to claim 2 further comprising the step of constructing the set of separate viewing vectors containing said viewing point and each of the separate viewing vectors extending to a respective one of a plurality of voxels contained in said viewing frustum, wherein a position of said viewing point is located within said volume data.
- 10 17. The method according to claim 16 further comprising the step of selecting the image parameter for determining a resolution of said refined grid, the image parameter being a step size, wherein a viewing angle contained by said viewing frustum and said viewing direction vector is less than 90° .
- 15 18. The method according to claim 1 further comprising the step of restricting the re-sampling step to selected ones of the set of the plurality of viewing vectors in said viewing frustum, said selected ones having a preliminary major axis different from said major axis of said viewing direction vector.
- 20 19. A method according to claims 15, wherein the rendering of said factorized data produces a 3-D image.
- 25 20. A system for generating in substantially real-time fashion in response to input from a use of a 2-D image projection directly from a 3-D volume data, the system comprising:
- 30 a) a memory for storing the volume data;
- b) a processor for factorizing and rendering an image data set selected from said volume data, the image data set including a viewing frustum having a viewing direction vector with a selected major axis and a plurality of viewing vectors; and
- c) a user interface for providing said processor with an image parameter, said image parameter to be used in generating the image projection;
- d) a display for displaying said image projection provided by said processor; and e) a refined grid used by said processor for re-sampling a selected set of the viewing vectors in said image data set;

wherein said image parameter facilitates determination of a resolution of said refined grid to provide each vector of the selected set of viewing vectors with the same major axis of the direction vector.

- 5 21. A system according to claim 20, wherein said image parameter includes a viewing point and a central point, said central point is substantially centered in said 2-D image projection.
22. The system according to claim 21, wherein said viewing point and said central point
10 are used for determining a viewing direction for said 2-D image projection.
23. The system according to claim 22, wherein the major component of said viewing direction vector is used for determining a major axis in a sheared object space, said refined grid is applied along said major axis.
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24. The system according to claim 20, wherein said volume data is stored in said memory as a stack of 2-D image slices.
25. The system according to claim 24, wherein said processor accesses said memory once
20 for every selected one of said 2-D image slices.
26. The system according to claim 25, wherein said processor accesses said memory in a predefined storage order.
- 25 27. The system according to claim 20, wherein said image parameter is used for determining a resolution step size of said refined grid.
28. The system according to claim 24, wherein said stack of 2-D image slices is obtained from an imaging system selected from the group comprising CT, MRI, and
30 Ultrasound.
29. The system according to claim 26, wherein the processing of said image dataset produces a 3-D image.

30. A computer program product for generating a 2-D image projection directly from a 3-D volume data, the product comprising:
- a) a compute readable medium for providing instructions for a processor;
 - b) a selection module stored on the computer readable medium for determining a viewing frustum having a viewing direction vector with a selected major axis, the viewing frustum containing a plurality of viewing vectors;
 - c) a user interface module coupled to the selection module for providing an image parameter;
 - d) a re-sampling module coupled to the user interface module for re-sampling a selected set of the viewing vectors in the volume data with a refined grid according to the selected image parameter;
 - e) a generator module for applying a shear factorization and warp operator to the re-sampled set of viewing rays according to the selected image parameter to produce the image projection displayable on a display;
- wherein the image parameter is selected so as to provide each vector of the selected set of viewing vectors with the same major axis of the direction vector.
31. The product according to claim 30, wherein selection of the image parameter provides a step size used to define a resolution of the refined grid.
32. The product according to claim 31, wherein the step size is used to modify the shear factorization.
33. The product according to claim 31, wherein the boundaries of the viewing frustum is determined by constructing boundary vectors, each of the boundary vectors including a viewing point and extending to each respective corner of the volume data, wherein the viewing point is positioned external to the positions contained by the volume data.
34. The product according to claim 31, wherein the set of viewing vectors contains a viewing point and each of the viewing vectors of the set extends to a respective one of a plurality of voxels contained in the viewing frustum, the viewing point is located within the volume data/

35. The product according to claim 34, wherein a viewing angle contained by the viewing frustum and the viewing direction vector is less than 90° .
36. The product according to claim 34, wherein the re-sampling is restricted to selected ones of the set of viewing vectors in the viewing frustum, the selected ones having a preliminary major axis different from the major axis of the viewing direction vector.
37. The product according to claim 36, wherein the viewing frustum is determined by specifying positional data of the viewing point and a central point, the central point being substantially centered in the 2-D projection.
38. The product according to claim 32, wherein the warp operator is independent of the step size selected.
39. The product according to claim 36, wherein processing of the selected set of the viewing rays produces a 3-D image displayable on the display.